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Title:

In-situ metal nanoparticles exsolution on perovskite oxides for catalytic membrane reactors

Authors & affiliations:

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Abstract: (Your abstract must use **Normal style** and must fit in this box. Your abstract should be no longer than 300 words. The box will 'expand' over 2 pages as you add text/diagrams into it.)

Preparation of Your Abstract

1. The title should be as brief as possible but long enough to indicate clearly the nature of the study. Capitalise the first letter of the first word **ONLY** (place names excluded). No full stop at the end.

2. Abstracts should state briefly and clearly the purpose, methods, results and conclusions of the work.

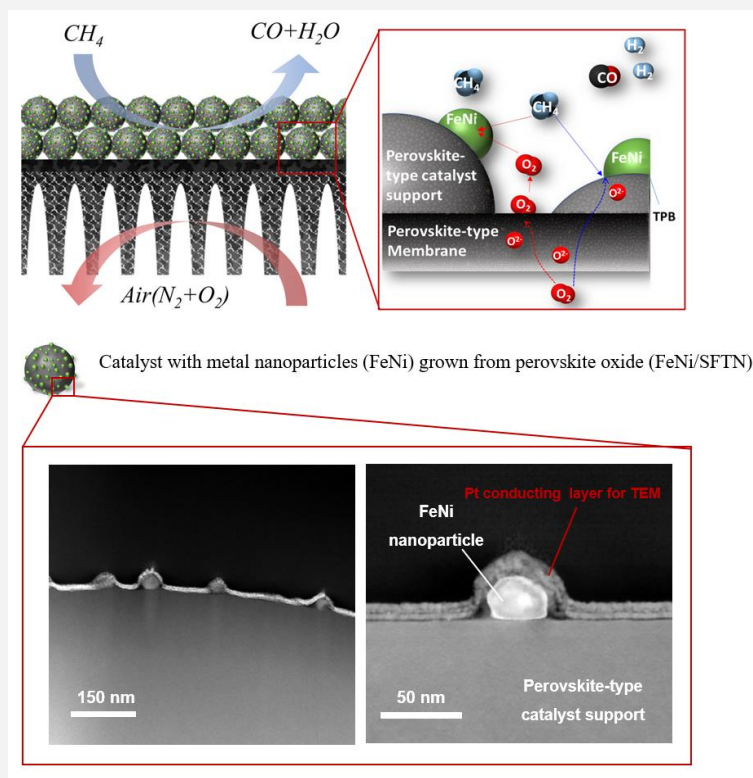
Introduction: Clearly state the purpose of the abstract

Methods: Describe your selection of observations or experimental subjects clearly

Results: Present your results in a logical sequence in text, tables and illustrations

Discussion: Emphasize new and important aspects of the study and conclusions that are drawn from them

Catalytic membrane reactors (CMRs) are considered a significant development direction in the capture and utilization of CO₂. It couples catalytic and separation processes in a single unit operation, enabling real-time separation of reaction products. Conventional metal nanoparticle catalysts (based on Fe, Ni, etc.) tend to have high activity in CMRs, whereas the poor thermal stability of nanoparticles will result in particle sintering and deactivation problems upon high-temperature annealing (>700 °C). These issues have severely limited the development of CMRs.



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Our recent work provided a new concept for designing a perovskite catalytic membrane reactor to balance stability and activity. In this reactor, homologous $\text{Sr}_{0.9}\text{Fe}_{0.81}\text{Ta}_{0.09}\text{Ni}_{0.1}\text{O}_{3-\delta}$ (SFTN) perovskite oxides were used as metal particle carriers. The population, distribution and size of nanoparticles can be controlled by manipulating the reduction temperature and time. After reduction at 850 °C for 2 h, the FeNi alloy nanoparticles were grown in-situ from the SFTN and uniformly anchored on the surface, with a size limit of about 50 nm. The four-channel hollow fiber CMRs constructed with this catalyst show superior catalytic activity over the fixed-bed reactor for the partial oxidation of methane to produce syngas. The methane conversion, carbon monoxide selectivity and hydrogen selectivity are 98%, 97% and 98%, respectively, while the hydrogen/carbon monoxide ratio was 2.2. The newly developed FeNi/SFTN catalyst combines high stability against agglomeration and poisoning with high activity. Benefiting from the constant removal of oxygen from the membrane surface, these advantages of catalyst are amplified in membrane reactors, which in turn effectively inhibit its excessive exsolution/dissolution.

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